Press Release

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FLOSFIA

京都大学 KYOTO UNIVERSITY

Ground breaking work on Gallium Oxide（Ga_2O_3）normally-off transistor

～Paved a way for Gallium Oxide as standard material for power semiconductor～

FLOSFIA Inc.

Kyoto University

【Background】

Minimizing conversion loss of power devices is critical in order to realize energy-saving society. The power devices are the key components for transferring electricity between its AC and DC forms and changing its voltage and frequency and integrated in AC adapter, electric vehicles, robots and home appliances. For power devices, silicon dominates, generating sales of more than $20 billion per annum. However, the silicon power devices are far from perfect. When deployed in power systems, 10 percent of electrical energy can be wasted as heat − and addressing this weakness is not easy, because silicon devices are approaching their theoretical limit. Industry has been challenging to achieve higher efficiencies with new semiconductor materials.

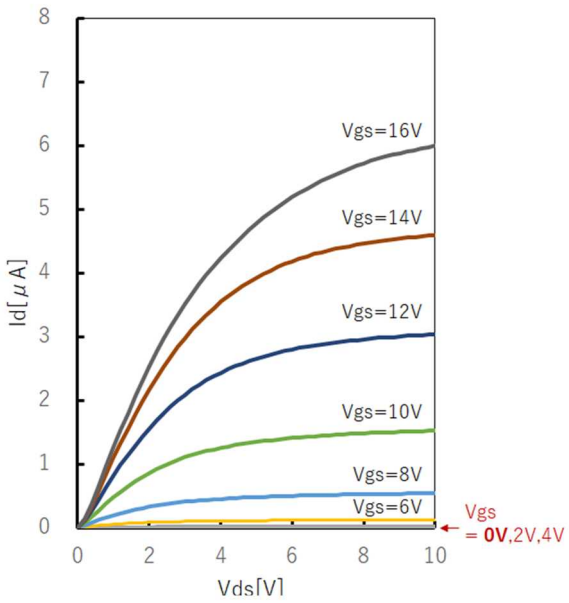

Figure 1 I-V curve of normally-off Ga_2O_3 MOSFET

Gallium Oxide (Ga_2O_3) is a very promising material for the next generation power devices. It comes in five different phases with its α-phase which takes the corundum crystal structure possessing the most attractive material properties. Kyoto University demonstrated the world-first single crystal growth of corundum α-Ga_2O_3 on sapphire in 2008. In 2015, FLOSFIA fabricated α-Ga_2O_3 schotty barrier diode (SBD) showing specific on-resistance of 0.1mΩcm^2, the world's lowest specific on-resistance ever. FLOSFIA, then, launched an engineering sample of α-Ga_2O_3 SBD packaged in TO220, a big step toward commercialization.

Another challenge FLOSFIA has been taking is to demonstrate corundum α-Ga_2O_3 metal-oxide-semiconductor field-effect transistor (MOSFET). In 2016, FLOSFIA and Kyoto University jointly discovered p-type Iridium oxide (Ir_2O_3), which has the same corundum structure as the α-Ga_2O_3, could be expected to form a gallium oxide-based power MOSFET.

【Results】

FLOSFIA successfully demonstrated α-Ga_2O_3 normally off MOSFET. (Figure 1) The world-first α-Ga_2O_3 normally-off MOSFET comprises of N+ source/drain layer, p-type well layer, gate insulator, and electrodes. (Figure 2 and 3) The gate threshold voltage extrapolated from I-V curve was 7.9V. The device is made of a novel p-type corundum semiconductor which functions as an inversion layer. This is a ground-breaking work since there has been no theoretical study predicting p-type material which is compatible with n-type Ga_2O_3 until we discovered p-type Ir2O3 in 2016, and thus it has been considered challenging to realize normally-off MOSFET.

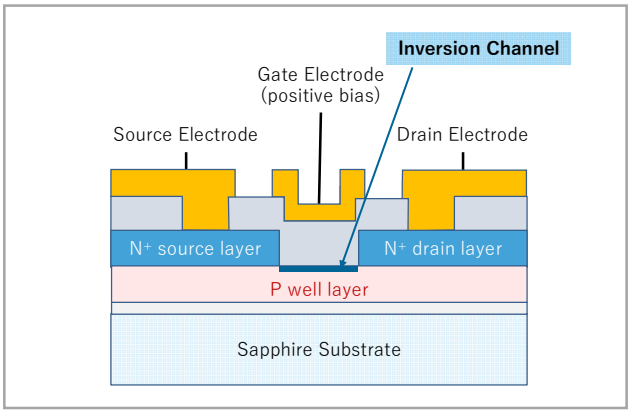

Figure 2　Cross sectional device schematic

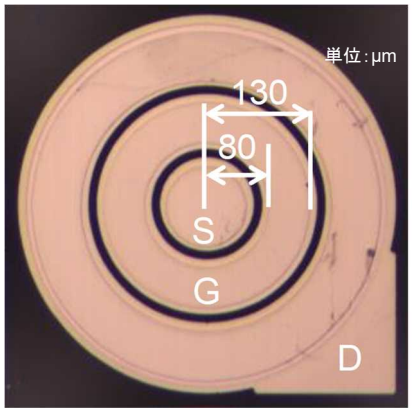

Figure 3 Optical micrograph of normally-off Ga_2O_3 MOSFET

【Road to commercialization】

FLOSFIA plans to manufacture corundum α-Ga_2O_3 power devices, GaO™ series, starting from SBD in TO220 and then MOSFET, which will be integrated in AC adopters, driver circuit of robots, electric vehicles, home appliances, power conditioner for solar cells, and so on. The GaO™ has a potential to miniaturize inverters down to tenths of and driving cost down to half of conventional ones while maximizing conversion efficiency.

【FLOSFIA Inc】

FLOSFIA Inc., headquartered in Kyoto, Kyoto prefecture, Japan, is a spin-off from a research of Kyoto University, specializing in film-formation by mist chemical vapor deposition (CVD). Making use of physical properties of gallium oxide (Ga_2O_3), FLOSFIA has devoted to development of low-loss power devices. FLOSFIA succeeded in a development of a Schottky Barrier Diode (SBD) with the lowest specific on-resistance of any SBDs currently available on the market (through an internal investigation), realizing technologies linked to power loss reduction that is reduced up to 90 percent less than before. FLOSFIA produces a variety of thin films, enhancing MISTDRY™ technology, achieving commercialization of power devices, and realizing application of its technology to electrode materials, oxide compounds with functional properties for electronic devices, plating and polymers.

FLOSFIA

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